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(54) IMPROVEMENTS IN OR RELATING TO HEAT-EXCHANGER CORES EACH WITH A SINGLE ROW OF TUBES

(71) We, SOCIETE ANONYME DES USINES CHAUSSON, a Company duly organised under the laws of France, of 35, rue Malakoff, ASNIERES, Hauts-de-Seine, France, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to heat exchangers each comprising a single row of circulation tubes for a fluid to be heated or cooled as a result of heat exchange with another fluid passing through the heat exchanger.

In one type of known heat exchanger, the heat exchanger core has a plurality of parallel fins formed with holes through which pass tubes extending substantially at right angles to the fins. Such heat-exchangers are generally referred to and are herein defined as "plate-fin type heat exchangers".

According to one aspect of the invention, there is provided a plate-fin type heat exchanger core wherein all tubes of the core form a single row of parallel tubes, each tube being of a substantially rectangular cross-section, in which the value of C_2/C_1 as greater than 8, with C_1 being the outer width of the cross-section of each tube and having a value between 1 and 10 mm, and C_2 representing in mm the outer length of the cross-section of that tube, the cross-section being taken at right angles to the tube.

In another type of known heat exchanger, the heat exchanger core has a plurality of tubes arranged in a single row and a plurality of fins which extend between and into contact with adjacent tubes of the row. The fins are corrugated and generally extend lengthwise of the tubes. Such heat exchangers are generally referred to and are herein defined as "corrugated-fin type heat-exchangers".

According to another aspect of the invention, there is provided a corrugated fin type heat-exchanger core wherein all tubes of the core form a single row of parallel tubes, each tube being of a substantially rectangular cross-section, in which the value of C_2/C_1 is greater than 8, with C_1 being the outer width of the cross-section of each tube and having a value between 1 and 10 mm, and C_2 representing in mm the outer length of the cross-section of that tube, the cross-section being taken at right angles to the tube.

According to a preferred feature of this invention, the ratio E_t/C_2 is between 1 and 1.5, with E_t being the depth in mm of the core in a direction substantially parallel to the longitudinal axis of the tube cross-section.

According to another feature of this invention, the ratio C_2/D is greater than 2.6, with D indicating in mm the distance between the axes of two successive tubes.

According to still another feature of this invention, a so-called economical compactness ratio defined as:

$$\frac{C_2 \times D}{E_t \times t}$$

is equal to or greater than 3, with t indicating in mm the pitch of either the plate-fins of the first aspect of the invention or the corrugated fins of the second aspect of the invention and being between 0.2 and 6.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a partial view of one embodiment of heat exchanger core of the plate-fin type, and

Fig. 2 is a partial view of one embodiment of heat exchanger core of the corrugated fin type.

Referring now to the drawing, Figs. 1 and 2 show two types of exchanger core, namely a heat exchanger core of the plate-fin type and a heat exchanger core of the corrugated fin type, respectively. Each core comprises tubes 1 placed in a single row, these tubes being connected by secondary heat exchange elements 2, which are plate-fins in Fig. 1 and corrugated fins in Fig. 2, The tubes 1 are

connected to the secondary heat exchange elements 2, for example by brazing. The tubes 1 are of a substantially rectangular cross-section and may have rounded corners as emphasised in the drawing. The width and length of the rectangular cross-section, the cross-sections being taken at right angles to the tubes, are designated by C_1 and C_2, respectively.

The secondary heat exchange elements 2 of the two types of heat exchanger core have a width E_f defining the depth of the core in a direction substantially parallel to the longitudinal axis of the tube cross-section. The distance between the axes of the tubes is designated by D and the pitch of the secondary heat exchange elements 2 is indicated by *t*.

According to this invention, it has been found that to obtain particularly efficient heat exchangers with a single row of tubes, the outer width C_1 of each of the tubes must be between 1 and 10 mm and preferably between 1 and 4 mm, while the ratio C_2/C_1 must be greater than 8.

For the core to be particularly compact, the ratio E_f/C_2 must be between 1 and 1.5.

Especially satisfactory results are obtained with a pitch value *t* between 0.2 and 6 mm and preferably between 1 and 2.8 mm, while the ratio C_2/D of the outer length of the cross-section of each of the tubes of the respective distances between axes is preferably greater than or equal to 2.6.

In view to maximise the heat exchange with respect to the price of the materials constituting the core, it is important to take into consideration the so-called economical compactness ratio, i.e.:

$$\frac{C_2 \times D}{E_f \times t}$$

mentioned earlier.

Four types of heat exchanger cores with a single row of tubes have been manufactured, whilst taking into consideration the above criteria, and are designated A, B, C, D. Their various parameters and size are shown in the following table. It will be seen that the economical compactness ratio is preferably greater than or equal to 3. (The measurements being made in millimetres).

Example	A	B	C	D
C_1	1.8	1.8	2.5	2.9
C_2	23	28	32	25
E_f	25	32	38	28
D	8	8	9	9.4
t	1.2 to 1.8	1.5 to 2.1	1.5 to 2.1	1.5 to 2.1
C_2/C_1	12.8	15.6	12.8	8.62
E_f/C_2	1.08	1.14	1.19	1.12
$\frac{C_2}{D}$	2.87	3.5	3.55	2.64
$\frac{C_2 \times D}{E_f \times t}$	6.1 to 4.1	4.7 to 3.3	5.1 to 3.6	5.6 to 4.0

WHAT WE CLAIM IS:—

1. A heat exchanger core of the plate fin type (as hereinbefore defined) wherein all tubes of the core form a single row of parallel tubes, each tube being of a substantially rectangular cross-section, in which the value of C_2/C_1 is greater than 8, with C_1 being the outer width of the cross-section of each tube and having a value between 1 and 10 mm, and C_2 representing in mm the outer length of the cross-section of that tube, the cross-section being taken at right angles to the tube.

2. A heat exchanger core of the corrugated

fin type (as hereinbefore defined) wherein all tubes of the core form a single row of parallel tubes, each tube being of a substantially rectangular cross-section, in which the value of C_2/C_1 is greater than 8, with C_1 being the outer width of the cross-section of each tube and having a value between 1 and 10 mm, and C_2 representing in mm the outer length of the cross-section of that tube, the cross-section being taken at right angles to the tube.

3. A core as claimed in claim 1 or 2, wherein C_1 is between 1 and 4 mm.

4. A core as claimed in claim 1, 2 or 3, wherein the ratio E_f/C_2 is between 1 and 1.5 with E_f being the depth of the core in a direction substantially parallel to the longitudinal axis of the tube cross-section.

5. A core as claimed in any one of claims 1 to 4, wherein the ratio C_2/D is greater than 2.6, with D indicating in mm the distance between the axes of the tubes.

6. A core as claimed in any one of claims 1 to 5, wherein the ratio

$$\frac{C_2 \times D}{E_f \times t}$$

is greater than or equal to 3, with t indicating in mm the pitch of either the plate fins of the plate-fin type core or the corrugated fins of the corrugated fin type core and being between 0.2 and 6.

7. A core as claimed in any one of claims 1 to 6, wherein t is between 1 and 2.8.

8. A heat exchanger core with a single row of tubes, substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawings.

9. A heat exchanger core as claimed in claim 1 or 2 and being in accordance with any one of the foregoing Examples A, B, C or D.

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1497935 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

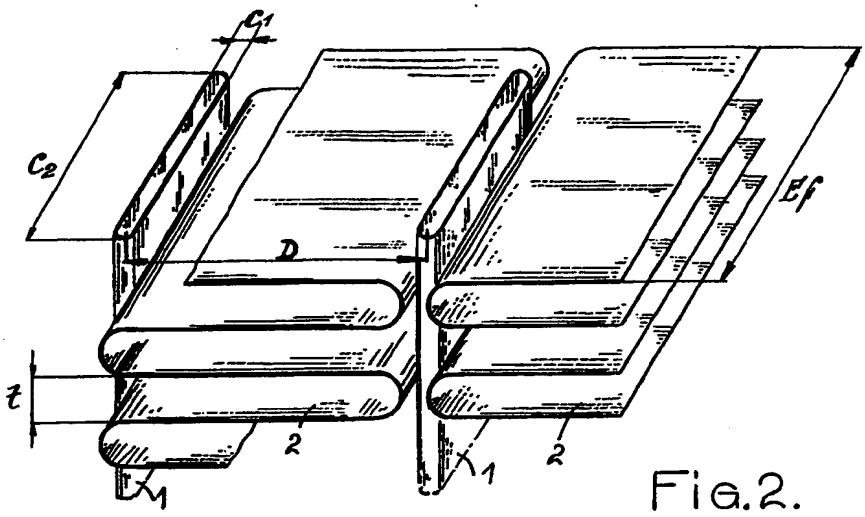

Fig.2.

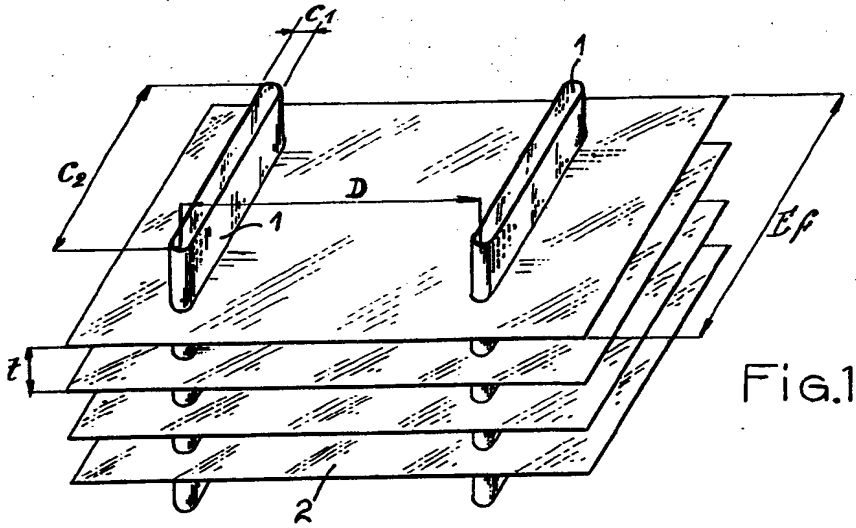

Fig.1.

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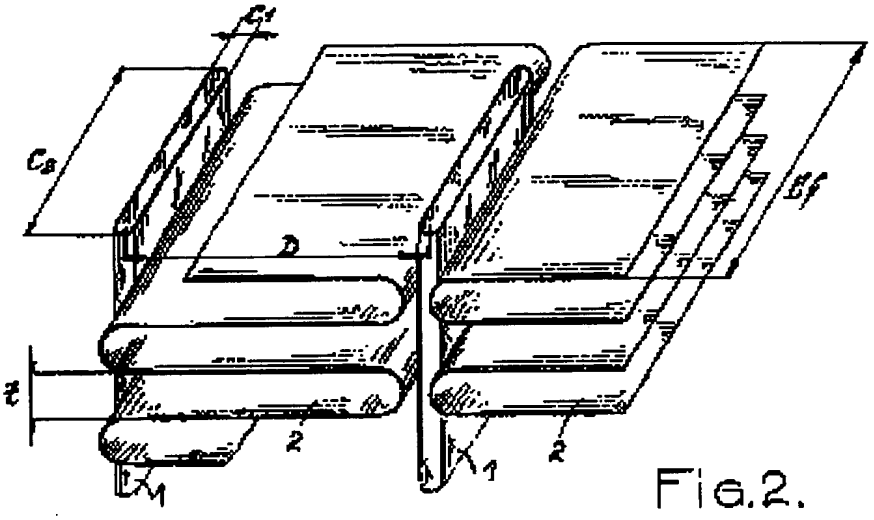

Fig.2.

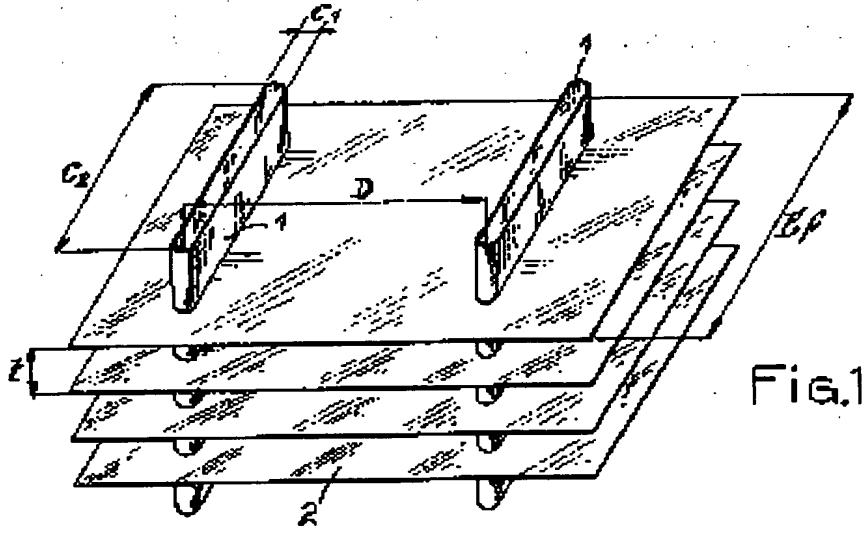

Fig.1.